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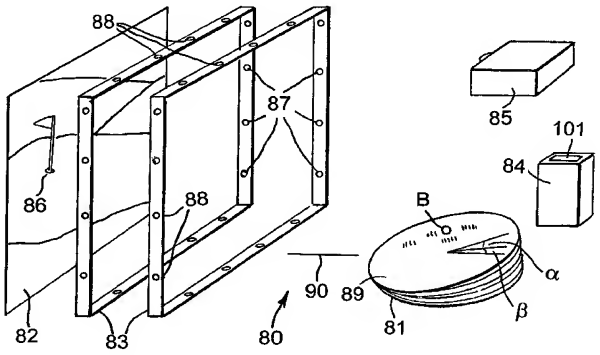

(57) Abstract: The present invention provides a golf simulator (80) comprising a launch area (81) facing a screen (82) at which the ball is driven and which is used to display an image (86) of part of a golf course. Sensor devices (83) detect at least one of: the impact of a golf ball on the screen (82), the flight of the ball towards the screen (82), and the trajectory of the golf club head during the golf club swing. The launch area is provided by a playing surface panel of a tiltable tee apparatus (81). At least one displacement device (95, 96) for tilting the playing surface panel (81) so as to provide a desired slope angle α and slope direction β relative to a golf driving direction. A computer apparatus (84) is operatively connected to the sensor devices (83) and to the displacement device (95, 96), and programmed so as to control display of part of a golf course on the screen (82), based on the topography of the golf course, and the position of the launch area in relation to the golf course, and compute an estimated trajectory of the ball on the basis of the inputs received from the sensor devices (83), compute an estimated position of the ball based on the estimated trajectory and the ball landing zone topography. The computer (84) then controls the display on the screen (82) so as to display the estimated position of the ball on the screen image (86), computes the slope angle α and slope direction β of the estimated position or lie of the ball. The computer (84) further controls the displacement device (95, 96) so as to bring the playing surface panel slope angle α and slope direction β into correspondence with the computed slope angle and slope direction so that the next drive can be played from a realistic lie.

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GOLF SIMULATOR

The present invention relates to improved golf simulators provided with lie simulation.

One of the particular disadvantages of the game of golf is the very large space it requires, which can make it very expensive where land is at a premium and/or require extensive travel from a city to a more or less remote golf course. In recent years various golf simulators have been developed which can provide some elements of realism by using projected images of a player's view of a golf course and of the ball's estimated position after it has been driven by a player. Various kinds of sensor are used to monitor the flight of the ball and/or the trajectory of the golf club head, and use the captured data to estimate the trajectory which the ball would have followed out in the unconfined space of the real golf course. With such simulators it is quite possible to "experience" playing holes from golf course from all around the world, in a small confined space which can readily be accommodated in the centre of a city or any other convenient location.

A particular feature of real-life golf courses is, however, the very diverse nature of different lies which may be encountered in a round of golf due to the varying topography of the course. Thus whilst the first drive for each hole will normally be played from a substantially level tee area, subsequent drives will often have to be played from lies with a variety of slope angles and slope directions relative to the direction in which the player wishes to drive the ball. A significant practical limitation of such golf simulators is that no provision is made for providing the player with such variations in lie, let alone in providing variations in lie

which are related to the estimated position of the ball after the last executed drive.

It is an object of the present invention to avoid or minimise one or more of the above disadvantages.

The present invention provides a golf simulator comprising a launch area facing a screen at which the ball is driven and which is used to display an image of part of a golf course; sensor devices formed and arranged for detecting at least one of: the impact of a golf ball on the screen, the flight of the ball towards said screen, and the trajectory of the golf club head during the golf club swing; a tiltable tee apparatus having a playing surface panel and at least one displacement device formed and arranged for tilting said playing surface panel so as to provide a desired slope angle and slope direction relative to a golf driving direction; and a computer apparatus operatively connected to said sensor devices and to said at least one displacement device, and programmed so as to control display of part of a golf course on said screen, based on the topography of the golf course, and the position of the launch area in relation to said golf course, and compute an estimated trajectory of the ball on the basis of the inputs received from said sensor devices, compute an estimated position of the ball based on the estimated trajectory and the ball landing zone topography, control said display on the screen so as to display the estimated position of the ball on the screen image, compute the slope angle and slope direction of the estimated position or lie of the ball, and control said at least one displacement device so as to bring the playing surface panel slope angle and slope direction into correspondence with the computed slope angle and slope direction so that the next drive can be played from a realistic lie.

Various different kinds of displacement device may be used in accordance with the present invention. Thus on the one hand there may be used various pressurized fluid, e.g. hydraulic or pneumatic, operated devices. Alternatively there may be used various mechanical devices driven by motors, conveniently electric motors, typically via suitable gears and/or other drive transmission mechanisms. Separate displacement devices may be used to provide tilting of the playing surface panel and rotation of (at least) the playing surface panel. Alternatively there could be used an arrangement where several, e.g. at least three, independently operable displacement devices are used to raise selectively, different sides of the playing surface panel, thereby providing different slope directions without the need for rotation of any part of the tee platform. Various suitable forms of tiltable tee apparatus are known in the art including designs such as those described in US Patent Nos 5820478, 5558334, and 5549522.

It will be appreciated that various different kinds of known golf simulator could be adapted in accordance with the present invention. One suitable type of golf simulator is described in US Patent 5,846,139.

In one preferred form of golf simulator of the present invention, the tiltable tee apparatus is provided with control signal receiving inputs for a tee platform tilting device motor and a tee platform rotation drive motor, for tilting and rotation of the tee platform respectively, towards required slope angle and slope direction or orientation values, said control signal receiving inputs being operatively connected to the computer of the golf simulator so that the slope angle and slope direction of the tee platform may be adjusted under the

control of the computer so as to be brought into correspondence with the slope angle and slope direction values at the estimated position of the ball as defined by the ball landing zone topography.

It will be appreciated that the computer can be used to control the tee platform in various ways. Thus on the one hand there may be used drive motors such as stepper motors which are drivable between positions with fixed predetermined relationships to given reference positions so that a control signal from the computer to achieve a desired slope angle and/or slope direction is executable directly. On the other hand there may be used a feedback system with slope angle and slope direction sensing devices provided on the tiltable tee platform and having outputs for slope angle and slope direction signals, respectively; and a tee platform tilting device motor and the tee platform rotation drive motor, for tilting and rotation of the tee platform respectively, towards required slope angle and slope direction values.

Various suitable angular displacement sensors may be used for the slope angle and slope direction (orientation) sensing devices, and include resistive or capacitative sensors, optical sensors, LVDT sensors, etc. It will of course be appreciated that either similar or different kinds of sensor may be used for the slope angle and slope direction sensing devices.

Thus in accordance with one preferred aspect the golf simulator of the present invention there is used a tiltable tee apparatus having:

a slope sensing device and slope direction sensing device having outputs for slope angle and slope direction signals, respectively; and

control signal receiving inputs for a tee platform tilting drive motor and the tee platform rotation drive motor, for tilting and rotation of the tee platform, respectively, towards required slope angle and slope direction values; said slope and slope direction sensing devices and said slope and slope direction control signal inputs of said apparatus being operatively connected to the computer of a said golf simulator so that the slope and slope direction of the tee platform may be compared by said computer with the slope and slope direction of the golf course, at the estimated position of the ball in the ball landing zone, and the computer generate control signals for tilting and rotation of the tee platform so as to bring the slope angle and slope direction of the tee platform into correspondence with the slope angle and slope direction values of said estimated position.

It will be appreciated that in use of the above apparatus, the tee platform would normally start in a neutral or zeroed configuration with zero slope corresponding to a flat tee-off launch area. After each drive has been completed the tee platform slope angle and slope direction is then adjusted via the simulator computer so as to bring it into correspondence with the slope angle and slope direction values at the estimated position of the ball after that drive, so that the launch area is reconfigured into a realistic lie dependent on the drive actually executed by the user.

A particularly suitable form of tiltable and rotatable tee apparatus comprises a ground support, and a tee platform rotatably mounted on said ground support, said tee platform comprising a base portion and a playing surface panel hingedly connected at a first edge portion to a corresponding edge portion of said base portion, said playing surface panel being supported at a jack support portion remote from said first

edge portion on an upper end of at least one screw jack pivotally connected thereto, said at least one screw jack having its lower end pivotally connected to said base portion, one of said ground support and tee platform base portion having a fixed spur gear secured thereto in a substantially horizontal plane on the rotational axis of said rotable tee platform, and the other having mounted thereon a drive motor with an elongate toothed drive output transmission member for driving engagement with said spur gear so as to rotate said tee platform in use of the apparatus, whereby in use of the apparatus said tee platform may be tilted throughout a range of slope angles and slope directions by operation of said at least one screw jack and said tee platform rotation drive motor.

This apparatus has the particular advantages of providing good stability using an economic and reliable form of construction. This is particularly beneficial in view of the relatively rapid movements and strong forces utilised in a golf swing which impose considerable stresses of all kinds on a platform, and it is particularly important both for the integrity of the apparatus and for the avoidance of disturbing the player's equilibrium and concentration, that the tee platform should be as stable as possible.

Various forms of elongate toothed drive output transmission member may be used which provide substantial resistance to any unintentional movement of the rotatable tee platform when the drive transmission member is not being driven. Thus, for example, there may be used a worm screw rotated by the motor directly, or preferably via a suitable reduction gear system. Advantageously though there is used an elongate rack member driven by a screw jack or the like operated by said drive motor.

With an apparatus of the present invention the rotation and tilting of the tee platform can readily be controlled in a substantially precise manner with minimal play between the relatively movable parts. Furthermore, the use of a screw jack mechanism provides for a fail safe and positive maintenance of a desired slope angle in a particularly simple and effective manner without the need for any additional braking or locking mechanisms, and with a playing surface panel hingedly connected at one edge to the base portion, the stability of the tee platform is further increased in a particular simple and economic manner.

Various kinds of screw jack device may be used in the apparatus of the present invention, including, for example so-called scissor jacks. Preferably though there is used a telescopic screw jack which generally comprises an elongate housing portion with a captive nut through which an elongate screw is secured into and out of the housing portion for telescoping therewith. Advantageously the screw jack is driven by a motor, usually an electric motor, preferably via a reduction gear-box. Similarly the motor used to rotate the tee platform is also usually electric and preferably provide with a reduction gear box in order to limit the speed of movement of the tee platform and improve control thereof.

Advantageously, the stability of the tee platform, may be yet further increased against any possible pitching on its rotatable mount by an annular bearing support extending radially outwardly of the rotatable mount. Any suitable form of bearing support may be used including, for example, a multiplicity of angularly distributed roller bearings.

In order to increase further the stability of the tee platform against any rotational displacement thereof in reaction to the swing of a golfer standing on the tee platform in use thereof, there is advantageously provided a locking device which is engagable, preferably automatically engagable, after the tee platform has been rotated to a desired position. Conveniently there is provided a locking device configured to be normally locked, being unlocked upon activation of the tee platform rotating drive motor, and re-locked upon deactivation of the drive motor. One particularly suitable form of locking device comprises a plurality of angularly distributed electromagnet units with axially displaceable elements with end portions which function as brake pad elements extending into braking engagement with a disk brake type plate when the electromagnets are powered up, and returning to a retracted position when the electromagnets are powered down.

The playing surface panel is generally provided with an artificial turf synthetic matting simulating grass for supporting the ball on, and advantageously the matting has an outer annular zone with shorter turf for simulating fairway, an inner annular zone with longer turf for simulating rough, and a central zone having a non-slip surface for supporting a player thereon, typically of a natural or synthetic rubber material, or other polymeric material having a surface adapted to provide good friction. If desired the material could have a limited degree of resilience. Advantageously the material is configured or formulated so as to shed water to avoid compromising its non-slip properties.

It is generally preferred, that the top surface of the matting should be substantially level in order to provide the player with a more natural looking playing surface. In this case different turf lengths for the different zones, can be

provided by using a stepped substrate into which the artificial turf fibres are anchored. A suitable turf length for the outer "fairway grass" ball support zone would generally be in the range from 5 to 15 mm, for example, about 12 mm, and for the inner ball "rough grass" support zone generally in the range from 20 to 40 mm, for example, about 25 mm. If desired, the effective turf height can be varied when required by the simple expedient of sprinkling a layer of sand or other like particulate material onto the substrate between the turf fibres. The sand is retained by the fibres when the tee platform is tilted, and can be removed when no longer needed by a vacuum cleaner apparatus. Typically the central player support zone would have a diameter of the order of 1000 mm to 1300 mm, whilst the annular "fairway" and "rough" zones would each have a radial depth or width of around 125 to 250 mm, for example about 200 mm.

It will be appreciated that, for particularly steep lies, even the longer turf may be insufficient to retain the ball in position and the platform is advantageously provided with a flexible tubular tee generally of the kind used in driving ranges, but with an angled top end. The tubular tee is desirably mounted in a suitable recess in the platform substrate so as to be rotatable so that when the platform is tilted, the tubular tee can be rotated so that the angle of its top end relative to the horizontal is minimised thereby better to support the ball.

It will be understood that various forms of sensing devices, image display systems, and other golf simulator components, suitable for use in the simulators of the present invention, are already known in the art and accordingly need not be discussed in any further detail herein.

Further preferred features and advantages of the invention will appear from the following detailed description of a preferred embodiment illustrated with reference to the accompanying drawings in which:

Fig. 1 is a partly cutaway side elevation of a tiltable tee apparatus suitable for use in a golf simulator of the invention;

Fig. 2 is a plan view of the apparatus of Fig. 1 with the playing surface panel removed;

Fig. 3 is a detail vertical sectional view of part of the drive mechanism for rotating the tiltable platform;

Fig. 4 is a partly sectioned plan view of the mechanism of Fig. 3;

Fig. 5 is a vertical section through part of the playing surface panel;

Fig. 6 is a partly cutaway side elevation of another tiltable tee apparatus suitable for use in a golf simulator of the invention;

Fig. 7 is a plan view of the apparatus of Fig. 6 with the playing surface panel indicated in chain-line and part of the tee platform cutaway to show part of the ground support;

Fig. 8 is a schematic perspective view of a golf simulator of the invention;

Fig. 9 is a block diagram indicating the principal components of the simulator of Fig. 8; and

Fig. 10 is a flow diagram indicating the operation of the simulator of Figs. 8 and 9.

Fig. 1 shows a tiltable tee apparatus 1 suitable for use in a golf simulator of the invention, said tiltable tee apparatus comprising a base plate ground support 2 and a tee platform 3 rotatably mounted 4 on said ground support 2. The tee platform 3 comprises a base portion 5 and a playing surface

panel 6 hingedly connected 7 at a first edge portion 8 to a corresponding edge portion 9 of the base portion 5.

The playing surface panel 6 is supported at a jack support portion 10 remote from said first edge portion 8 on the upper ends 11 of two spaced apart screw jacks 12 pivotally connected 13 thereto. The screw jacks 12 have their lower ends 14 pivotally connected 15 to the base portion 5. As shown in more detail in Figs. 3 and 4, the base plate 2 has a fixed spur gear 16 secured 17 thereto in a substantially horizontal plane on the rotational axis x-x of the rotatable tee platform 3, and the tee platform base portion 5 has a drive motor 18 driving a (further) screw jack 19 which has projecting axially from its extending portion 20 an elongate rack drive transmission member 21 for driving engagement 22 with the spur gear 16 so as to rotate the tee platform 3 in use of the apparatus 1.

The screw jacks 12 are mounted on a small support frame 23 on which is also provided a drive motor 24 fitted with a reduction gearbox 25 which has output drive shafts 26 at each end 27, 28 connected to respective ones of the screw jacks 12.

A control box 29 is mounted on the base portion 5 of the tee platform 3 and contains a configurable logic unit 30 which is used to control operation of the drive motors 18, 24, in response to commands from a detachable user control key pad 31 for rotating the tee platform 3 in either direction or raising and lowering it subject to the operation of contact limit switches 32a, 32b provided on the platform base portion 5 by the pivotally connected lower end 14 of one of the elevating screw jacks 12 and under one of the playing surface panel jack support portions 10, for defining maximum and minimum inclination (for example 30° and 0°), respectively and contact

limit switches 33a, 33b on the tee platform base portion 5 for maximum and minimum permitted extension of the rack drive transmission member 21 corresponding to platform rotation limits (usually 0° and 360°). A contact limit switch 34 is also provided on the hinge 7 under part of the hinge pin which is depressed in use of the apparatus by the weight of player standing on the tee platform 3, for the purposes of disabling the motors to prevent movement of the tee platform 3 when a user is stood on it. The tee platform base portion 5 is provided with a connector 35 for the lead 36 of the user control key pad 31 and a connector 37 for a detachable power supply 38 which is conveniently in the form of a rechargable battery pack. An externally accessible fuse box 39 is provided next to the connectors 35, 37.

In order to protect the working parts of the apparatus against weather and ingress of foreign bodies, and protect users from inadvertently trapping anything between the moving parts of the tee platform 3, the latter is provided with an annular concertina skirt 40 which readily extends and collapses as the playing surface panel 6 is raised and lowered.

As shown in Fig. 5, the playing surface panel 6 comprises a wooden tray 41 in which is disposed artificial turf matting 42 comprising a substrate 43 in which are anchored plastic filaments 44 simulating grass. As may be seen from the drawing, an annular outer zone 45 has a deeper substrate 43 and shorter turf filaments 44 for simulating a "fairway", while an inner annular zone 47 has a shallower substrate 43 and longer turf filaments 44 for simulating "rough". The matting can generally provide support to a golf ball 48 and hold it against rolling out of position when the playing surface panel 6 is inclined, without the need for a tee to support the ball. Nevertheless a flexible plastic tube tee 49

could also be provided on the panel 6, especially for use with greater panel inclinations providing steeper lies. As shown in the drawing the top end 50 of the tube tee 49 is angled at about 45o while the bottom end 51 is a push-fit into a recess 52 in the substrate 43 so that its angular orientation can be adjusted so that when the playing surface panel 6 is maximally inclined, the angled top end 50 is generally horizontal for supporting a golf ball thereon. In order to reduce the effective depth of the turf filaments 44, some sand 53 or the like can be sprinkled onto the matting 42 to raise the surface of the substrate 43. When this is no longer required it can be removed with a vacuum suction cleaner or the like. A central zone 53 on the playing surface panel 6 is formed of textured rubber 54 to provide a non-slip surface for a user 55 to stand on.

In use of the apparatus, a user will use the key pad 31 to raise or lower the playing surface panel 6 to the required slope inclination, and then rotate it to obtain the required kind of lie e.g. uphill or downhill, leftward or rightward slope etc. The user can then place the ball in the turf matting 42 of one of the annular zones 45, 47 or on a tee 51 mounted therein and step up onto the central player support zone 53 to play his/her practice drive.

Figs. 6 and 7 show the principal parts of a further embodiment generally similar to that of Figs. 1 to 5, with like reference numbers being used to indicate like parts.

In this embodiment the ground support 2 is in the form of a rectangular tubular metal frame 60 with outwardly projecting members 61 at its corners 62, the distal ends 63 of the members 61 being provided with screw adjustable 64 feet 65 to facilitate levelling of the apparatus 1.

The rotation of the tee platform 3 in this case is effected by means of an integrated drive unit 66 which includes a motor 67 driving a screw jack 68 which has an axially extending square rack 69 which engages the spur gear 16 tangentially as before. The mounting of the screw jacks 12 and associated drive motor 24, used to raise and lower the tee platform 3, have also been rearranged somewhat.

In this embodiment the ground support 2 is provided with an annular support ring 70 upon which rests a series of angularly distributed roller bearings 71 mounted to project from the underside 72 of the tee platform base portion 5, thereby providing additional support to the tee platform 3 to minimise pitching thereof on its rotatable mounting 4.

The support ring 70 also serves as a brake disc engagable by a pair of diametrically opposed brake pad units 73. In more detail the units 73 are in the form of electromagnet units with axially displaceable elements with end portions which function as brake pad elements extending into braking engagement with a disk brake type plate when the electromagnets are powered up, and returning to a retracted position when the electromagnets are powered down.

Thus when the tee platform rotation is activated through the control unit 31, the electromagnet brake pad units 73 are powered down and disengage from the support ring 70 to allow the tee platform 3 to be freely rotated by the integrated drive unit 66. When a desired orientation of the tee platform 3 has been reached, the drive unit 66 is powered down and the electromagnet brake pad units 73 simultaneously powered up again, pressing into the support ring 70 and thereby locking

the tee platform 3 even more firmly against any possible rotation.

It will be appreciated that various modifications may be made to the above described embodiments without departing from the scope of the present invention. Thus, for example, instead of a contact switch 31 activated by the weight of a user standing on the tee platform, there could be used a resistance switch which is triggered in response to the increased current drawn from the power supply due to the increased effort required to rotate the tee platform when someone is standing on it.

Fig.8 shows schematically a golf simulator 80 of the present invention comprising a launch area 81 facing a screen 82 at which the ball is driven, sensor devices 83 between the launch area 81 and the screen 82 for detecting the flight of a golf ball 8 from the launch area 81 to the screen 82, a computer 84 and a projector 85 for projecting an image 86 of part of a golf course onto the screen 82. The sensor devices 83 each have opposed horizontal and vertical arrays of infra red radiation emitters 87 and detectors 88. (It will be appreciated that a large multiplicity of these is used in order to obtain a relatively accurate 'fix' on the ball position as it passes the sensor devices 83, but only a few are shown for clarity.)

The launch area 81 is in the form of a tiltable tee apparatus such as that shown in Figs. 1-5 or Fig.6 and has its playing surface panel 89 tilted at a slope angle α to the horizontal and rotated away from the main axis 90 at a slope direction angle ß.

As shown schematically in Fig.9, the tiltable tee apparatus 81 is provided with tilt angle and orientation angle sensors 91,

92, for sensing the tilt angle α and the orientation angle ß of the playing surface 89, connected 93, 94 to the computer 84 for providing corresponding output signals thereto. The tee apparatus 81 also has its tilt motor 95 and orientation motor 96 connected 97, 98 to the computer 84 for receiving control signal inputs therefrom for adjusting the tilt angle α and orientation angle ß of the playing surface 89.

The ball flight sensor devices 83 are connected 99 to the computer 84 to provide ball flight data input signals thereto, and the projector 85 is connected 100 to the computer for receiving image data signals therefrom for display on the screen 82. The computer 84 is also provided with a user interface, conveniently in the form of a touch screen display 101, which can be used for inter alia resetting the simulator, entering user selections, eg, choice of golf course and/or hole to be "played", etc.

The operation of the simulator is summarized in Fig.10, when the simulator is to be used it is initially reset, with the tee platform being levelled so that the tilt angle α and orientation angle ß are both zero. The user then selects a particular course and/or particular hold which he(she) wishes to play. The computer computes the course view from the tee for the selected hole and this is then projected onto the screen by the projector. The user drives the ball towards the screen with the displayed golf course image and the flight of the ball is monitored by the sensing devices. The captured ball flight data is used by the computer to estimate the ball trajectory which is compared with the golf course topography data to estimate the ball landing position which is then displayed on the screen. The computer computes the slope angle and slope direction at the ball landing position lie from the course topographical data and compares it with the

values indicated for the playing surface of the tilting tee platform by the slope angle and direction sensors, and sends control signals to the tilting and orientation drive motors as required until these values have been brought into correspondence with those at the new lie. The computer also computes the new course view from the new lie and displays it on the screen via the projector, and the player may then make his second drive whereupon the process may be repeated.

It will be appreciated that it may be preferable for safety reasons to avoid any reconfiguration of the slope angle or direction of the playing surface of the tee platform while a player is still standing on the platform. This could be conveniently effected by for example requiring the player to dismount the tee platform and enter a suitable command on the computer user interface in order to release or disable a tee platform locking device.

CLAIMS

1. A golf simulator comprising a launch area facing a screen at which the ball is driven and which is used to display an image of part of a golf course; sensor devices formed and arranged for detecting at least one of: the impact of a golf ball on the screen, the flight of the ball towards said screen, and the trajectory of the golf club head during the golf club swing; a tiltable tee apparatus having a playing surface panel and at least one displacement device formed and arranged for tilting said playing surface panel so as to provide a desired slope angle and slope direction relative to a golf driving direction; and a computer apparatus operatively connected to said sensor devices and to said at least one displacement device, and programmed so as to control display of part of a golf course on said screen, based on the topography of the golf course, and the position of the launch area in relation to said golf course, and compute an estimated trajectory of the ball on the basis of the inputs received from said sensor devices, compute an estimated position of the ball based on the estimated trajectory and the ball landing zone topography, control said display on the screen so as to display the estimated position of the ball on the screen image, compute the slope angle and slope direction of the estimated position or lie of the ball, and control said at least one displacement device so as to bring the playing surface panel slope angle and slope direction into correspondence with the computed slope angle and slope direction so that the next drive can be played from a realistic lie.

2. A simulator according to claim 1 wherein the tiltable tee apparatus is provided with control signal receiving inputs for a tee platform tilting device motor and the tee platform rotation drive motor, for tilting and rotation of the tee

platform respectively, towards required slope angle and slope direction or orientation values, said control signal receiving inputs being operatively connected to the computer of said golf simulator so that the slope and slope direction of the tee platform may be adjusted under the control of the computer so as to be brought into correspondence with the slope angle and slope direction values at the estimated position of the ball as defined by the ball landing zone topography.

3. A simulator according to claim 2 wherein the computer is used to control stepper drive motors which are drivable between positions with fixed predetermined relationships to given reference positions so that a control signal from the computer to achieve a desired slope angle and/or slope direction is executable directly.

4. A simulator according to claims 2 wherein there is used a feedback system with slope angle and slope direction sensing devices provided on the tiltable tee platform and having outputs for slope angle and slope direction signals, respectively; and a tee platform tilting device motor and the tee platform rotation drive motor, for tilting and rotation of the tee platform respectively, towards required slope angle and slope direction values.

5. A simulator according to claim 4 wherein the slope angle and slope direction (orientation) sensing devices, are selected from resistive or capacitative sensors, optical sensors and LVDT sensors.

6. A simulator according to any one of claims 1 to 5 wherein is used a displacement device selected from: a pressurized fluid operated devices; a motor with a mechanical drive transmission.

7. A simulator according to claim 6 wherein separate displacement devices are provided for tilting of the playing surface panel and for rotation of, at least, the playing surface panel.

8. A simulator according to claim 6 wherein at least three, independently operable displacement devices are used to raise selectively, different sides of the playing surface panel, thereby providing different slope directions without the need for rotation of any part of the tee platform.

9. A simulator according to any one of claims 6 to 8 wherein is used a displacement device comprising an elongate toothed drive output transmission member in the form of a worm screw rotatable, in use of the apparatus, directly or indirectly, by a motor.

10. An apparatus according to claim 9 wherein the elongate toothed drive output transmission member comprises an elongate rack member driven by a screw jack device operated by said drive motor.

11. An apparatus according to claim 10 wherein at least one said screw jack is a telescopic screw jack.

12. A simulator according to any one of claims 1 to 5 wherein is used a tiltable and rotatable tee apparatus comprising a ground support, and a tee platform rotatably mounted on said ground support, said tee platform comprising a base portion and a playing surface panel hingedly connected at a first edge portion to a corresponding edge portion of said base portion, said playing surface panel being supported at a jack support portion remote from said first edge portion on an upper end of

at least one screw jack pivotally connected thereto, said at least one screw jack having its lower end pivotally connected to said base portion, one of said ground support and tee platform base portion having a fixed spur gear secured thereto in a substantially horizontal plane on the rotational axis of said rotable tee platform, and the other having mounted thereon a drive motor with an elongate toothed drive output transmission member for driving engagement with said spur gear so as to rotate said tee platform in use of the apparatus, whereby in use of the apparatus said tee platform may be tilted throughout a range of slope angles and slope directions by operation of said at least one screw jack and said tee platform rotation drive motor.

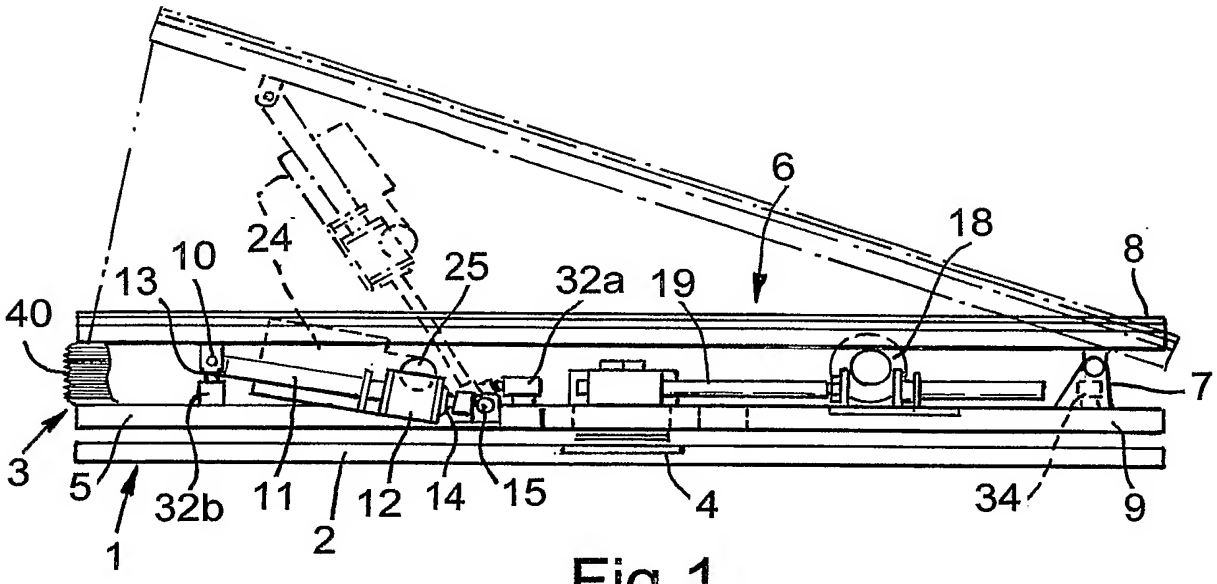
13. An apparatus according to any one of claims 1 to 12 wherein is provided a locking device which is engagable after the tee platform has been rotated to a desired position.

14. An apparatus according to claim 13 wherein said locking device comprises a plurality of angularly distributed electromagnet units with axially displaceable elements with end portions which function as brake pad elements extending into braking engagement with a disk brake type plate when the electromagnets are powered up, and returning to a retracted position when the electromagnets are powered down.

15. An apparatus according to any one of claims 1 to 14 wherein the playing surface panel is provided with an artificial turf synthetic matting simulating grass for supporting the ball on.

16. An apparatus according to claim 15 wherein the matting has an outer annular zone with shorter turf for simulating fairway, an inner annular zone with longer turf for simulating

rough, and a central zone having a non-slip surface for supporting a player thereon.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32b
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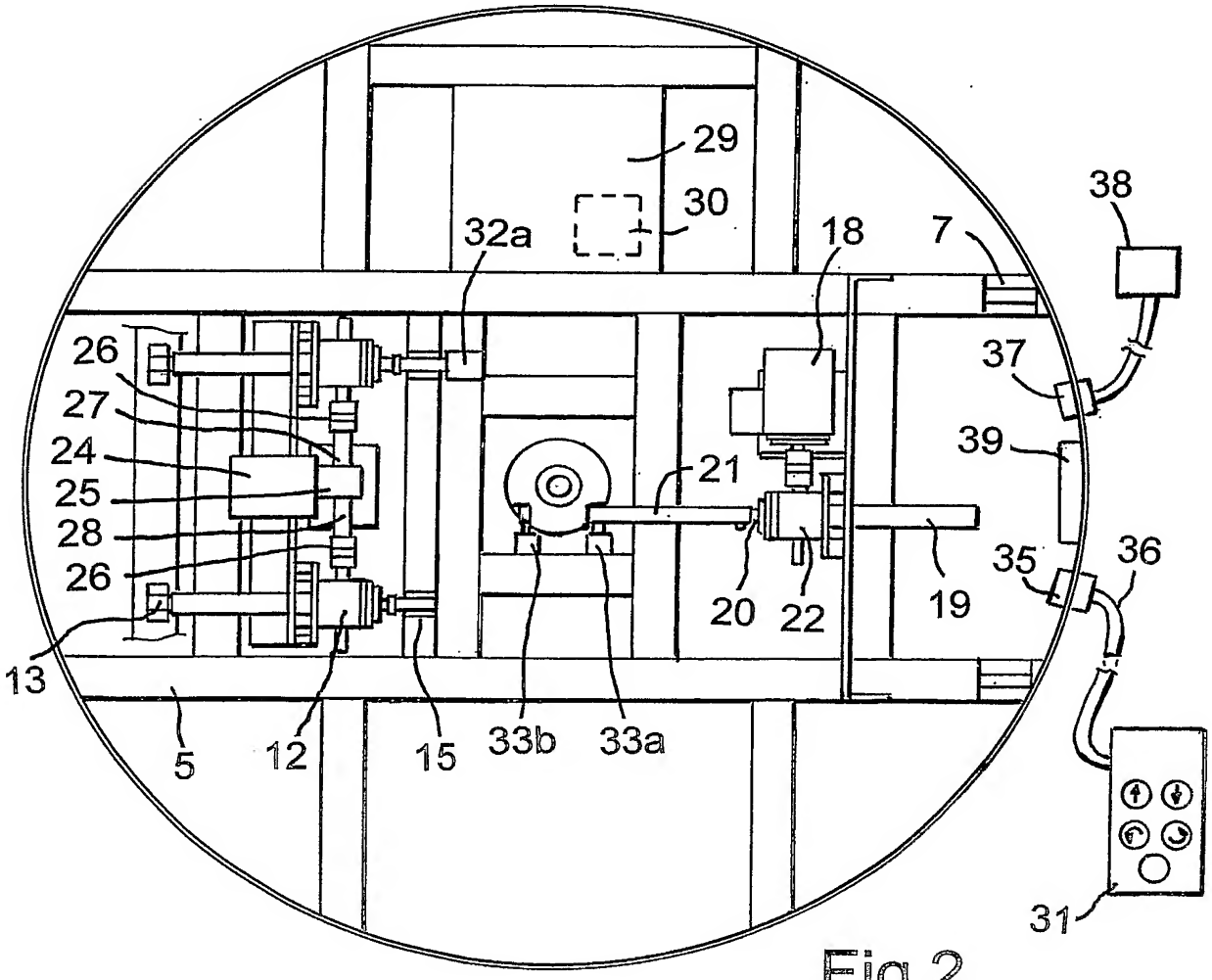
Fig.1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33b
33a
31

Fig.2

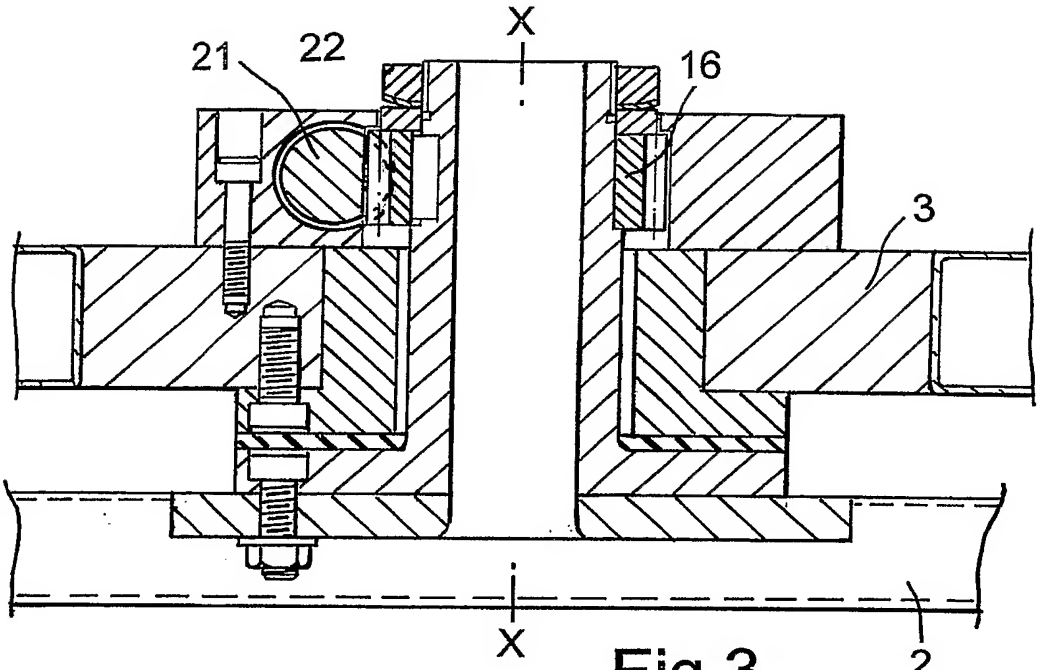

Fig.3

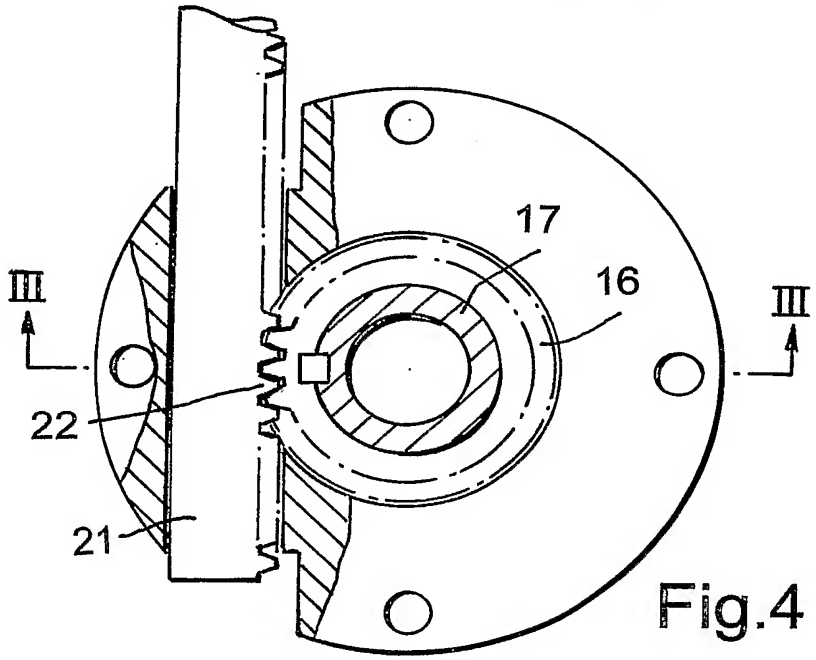

Fig.4

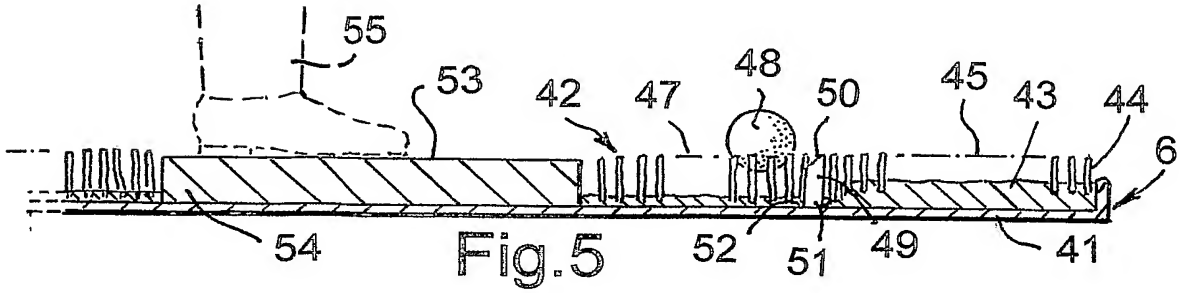

Fig.5

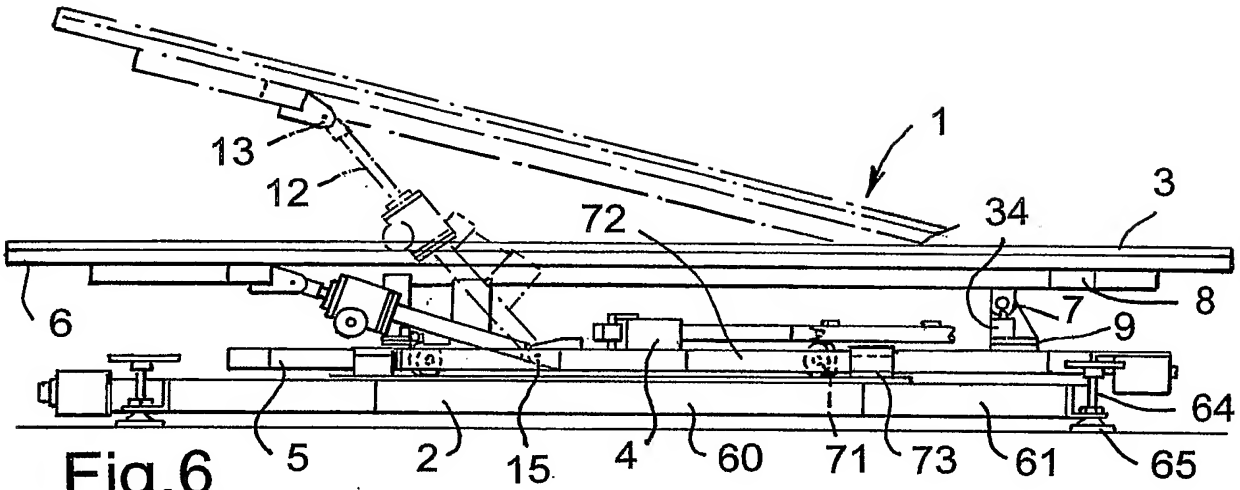
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Fig.6

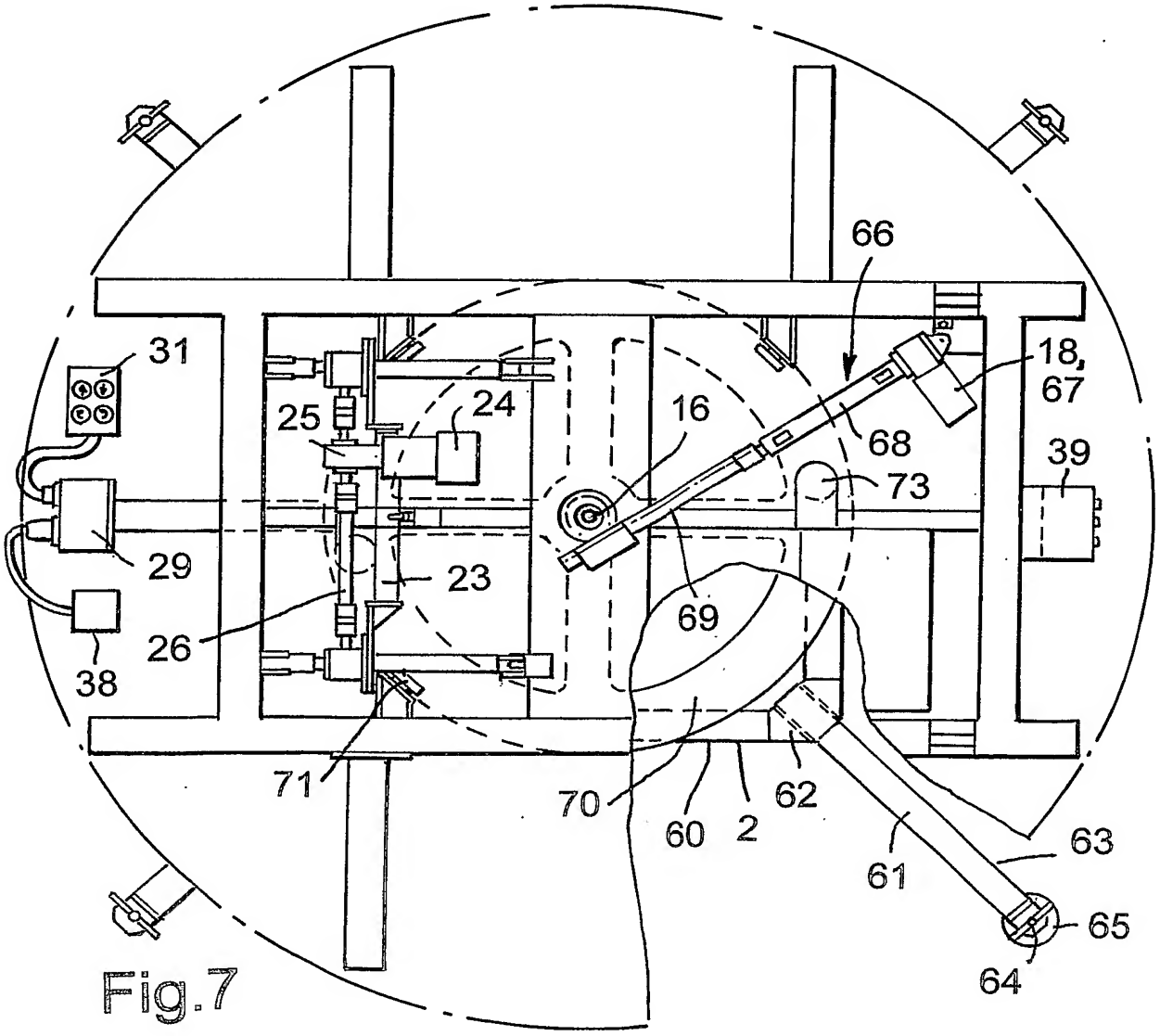
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Fig.7

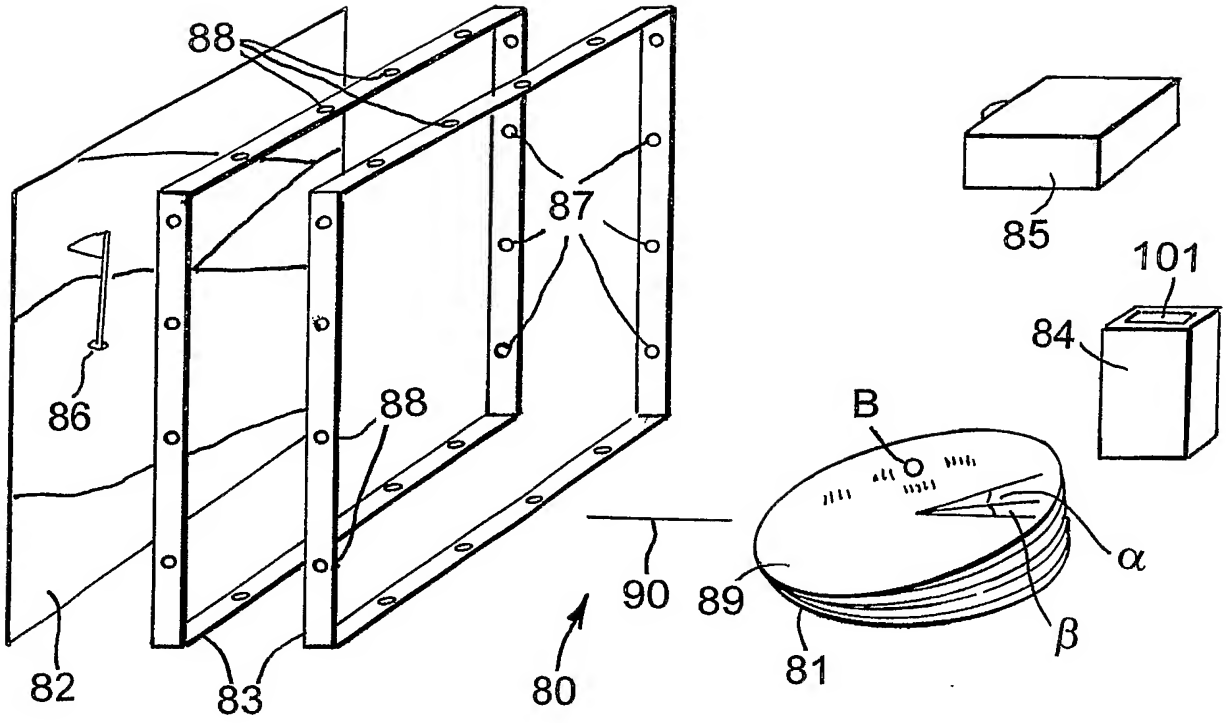
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Fig.8

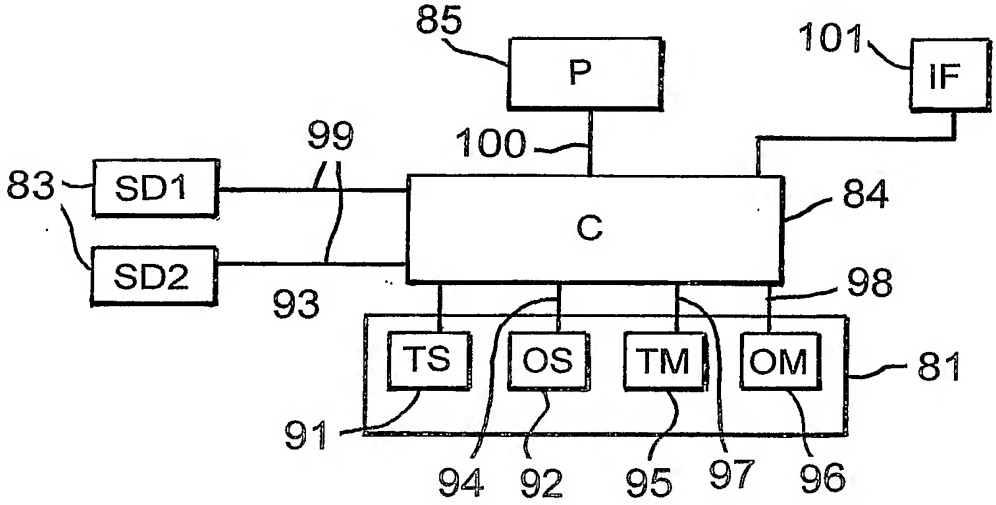
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Fig.9

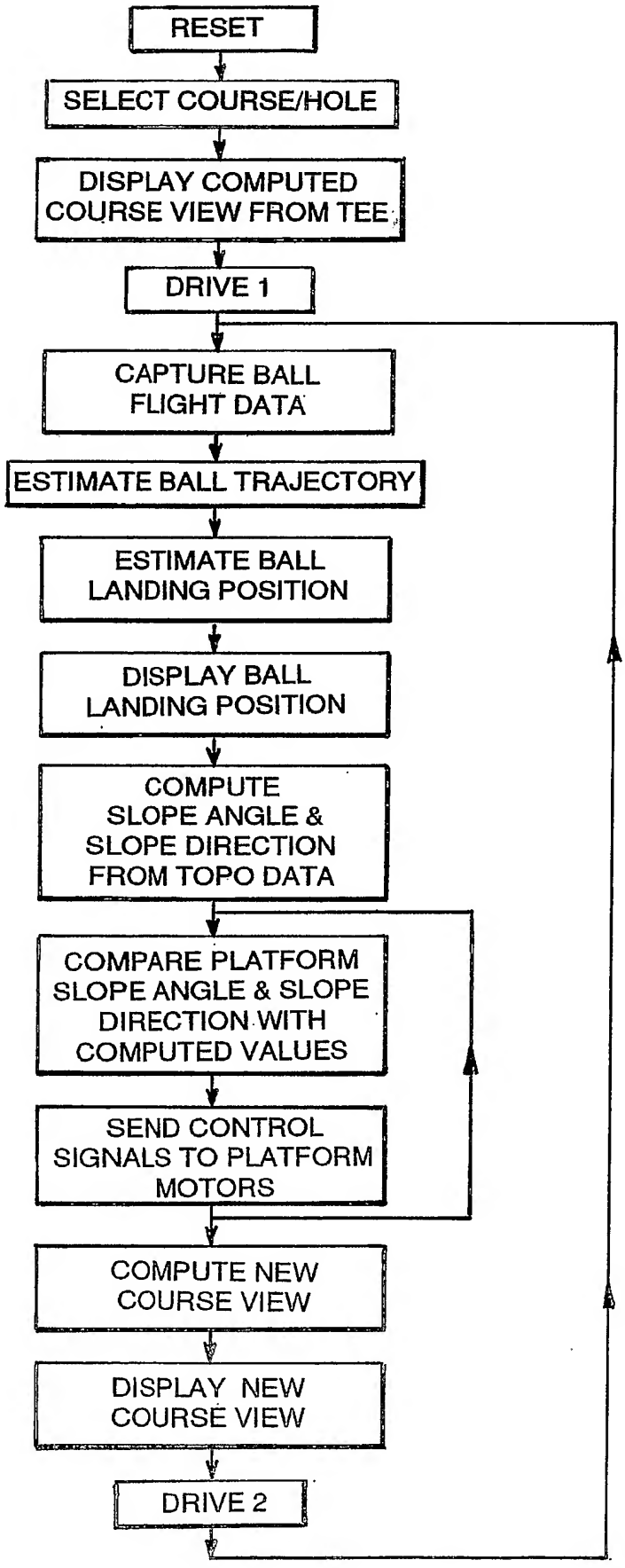
RESET
SELECT COURSE/HOLE
DISPLAY COMPUTED COURSE VIEW FROM TEE
DRIVE 1
CAPTURE BALL FLIGHT DATA
ESTIMATE BALL TRAJECTORY
ESTIMATE BALL LANDING POSITION
DISPLAY BALL LANDING POSITION
COMPUTE SLOPE ANGLE & SLOPE DIRECTION FROM TOPO DATA
COMPARE PLATFORM SLOPE ANGLE & SLOPE DIRECTION WITH COMPUTED VALUES
SEND CONTROL SIGNALS TO PLATFORM MOTORS
COMPUTE NEW COURSE VIEW
DISPLAY NEW COURSE VIEW
DRIVE 2

Fig.10